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Non-Formal Environmental Education in a Vulnerable Region: Insights from a 20-Year Long Engagement in Petrópolis, Rio de Janeiro, Brazil

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Received: 9 October 2018; Accepted: 14 November 2018; Published: 17 November 2018

Abstract: Environmental education is essential in the diffusion of the ethics, values, and skills that are critical to sustainable transformations. This paper presents the experience of non-formal environmental education approaches held in schools in the Petrópolis region of Rio de Janeiro, Brazil between 1997–2016. This paper adds to the literature on the relevant approaches and effectives of non-formal environmental education, especially in the vulnerable areas of low and middle-income regions that face critical environmental challenges. Specifically, to set up the context, this paper intends to firstly convey the commonly identified environmental sustainability challenges that the communities of the Petrópolis region are facing. Secondly, this report aims to convey key insights on how non-formal environmental education practices can strengthen gardening skills, environmental ethics, and sustainable food practices. These approaches have the potential to enhance the capacity of students toward sustainable transformations through encouraging them to be engaged with local social-environmental challenges. This paper adds new insights to the growing literature on non-formal environmental education, and it is hoped to inspire new educational approaches among sustainability educators.

Keywords: non-formal environmental education; environmental ethics; sustainable practices; vulnerable communities; Brazil

1. Introduction

The advancement toward sustainable development goals requires more attention to education, especially among children and young adults. Student participation in environmental education can greatly contribute to strengthening sustainability practices at the wider community level [1]. However, in reality, the pedagogical culture of the classroom tends to be centered on the teacher and follows rigid content guidelines directed by the state or national governments [2]. In this context, there are very few opportunities for interdisciplinary studies, practices, and deeper interpretations with local

experiences that are relevant to environmental ethics and practical sustainability skills in formal educational settings [3].

Against this background, researchers in the area of environmental education have called for more innovative practices in capacity building at the local level in order to increase the involvement of students in actual actions aiming for sustainable transformations [4]. Among them, school gardening and ecological walks are considered promising approaches of such participatory environmental education. These non-formal educational approaches help students acquire basic knowledge about climatic conditions, types of plants, and the environmental and economic realities of their local community area. Furthermore, these approaches enable the children of a local community to better reflect on ethical dimensions and receive practical skills related to environmental responsibility, such as soil maintenance and water conservation [5]. Topics related to health education, food sustainability, malnutrition, and obesity are other key learning areas that children can obtain from school gardening [6,7]. Furthermore, it is argued that school gardens and ecological walks can be an effective instrument for childhood development as it enables children to benefit from the emotional healing powers of nature, especially in economically and socially vulnerable regions [8,9].

Environmental education is originally defined as a type of education in, about, and for the environment [10]. This definition of environmental education essentially has its central focus in providing "opportunities to gain knowledge and skills that can be used to defend, protect, conserve, or restore the environment" [11]. However, as environmental problems are understood as the harmful impacts created by human activities to the ecological system, it is essential to examine the multiple dimensions of societies. The economic, sociocultural, and political structures of today's societies are the root causes of environmental challenges. Reflecting such realities, environmental education needs to incorporate the social dimension of the environmental challenges. Such evolvement in educational education is described by Mappin and Johnson [12], who argued that the purpose of environmental education has gradually expanded its scope and now encapsulates the multifaceted nature of environmental challenges. This also includes environmental ethics, i.e., the moral relationship between humans and their environment, most significantly under increasing anthropocentric activities [13] and ethical philosophies such as deep ecology [14].

In the context of the case study area of this study, environmental challenges are intertwined with the economic and social structures of the area, which are commonly found to be vulnerable. This study reports on the 20 years of engagement of non-formal environmental education led by the leading author of this paper, and addresses not only the knowledge and practical skills that have been used to conserve the local environment, but more so on the comprehensive empowerment that the project provided to the local youth through the environmental education.

While there is extensive literature on the effectiveness of non-formal environmental education approaches, there are a limited number of case studies reporting such approaches, especially in the vulnerable areas of low and middle-income regions, which face critical social-environmental challenges. This paper aims to address the question of: "how well can non-formal environmental education practices amplify the knowledge of youth about the local environment in a vulnerable region?" To answer this question, this paper applies a case study approach on 20 years of non-formal environmental education projects (from 1997 to 2016) in vulnerable schools of the Petrópolis region, State of Rio de Janeiro, Brazil. By doing so, this paper intends to convey, firstly, the environmental sustainability challenges that have been identified by students at the vulnerable communities in the Petrópolis region, and secondly, key insights on how non-formal environmental education practices contribute to increasing the community's capacity for sustainable transformations. In particular, this paper highlights how non-formal pedagogical approaches may be effective in situating environmental education within the local socio-economic, environmental, and institutional dynamics of vulnerable communities [15]. Deeper reflections on human behavior toward sustainable social transformations can be developed through the collaborative relationship between students, schools, and their local communities.

2. Methodology

This paper employs the case study methodology [16] to reveal key findings from 20 years (1997 to 2016) of non-formal environmental education approaches in the schools of the Petrópolis region, State of Rio de Janeiro, Brazil. More specifically, these schools include 31 schools spread across the Serrana region, which is located 700 m above sea level, and approximately 50 miles from the dense urban areas of Rio de Janeiro. These schools consisted of "elementary" and "junior high" schools that on average hosted 200 to 300 students (seven to 16-year-olds) per facility.

Inductive and qualitative methods [17] are particularly recommended to provide a deep and comprehensive portrait of the investigated phenomena. Case studies, more specifically, are a particular qualitative empirical strategy that have been employed by researchers examining a group of people undergoing an activity [16,18,19], and are particularly capable of revealing novel insights for theoretical development [20]. In this vein, the case study method is especially beneficial for developing key insights as to how the socio-environmental values are reflected in the educational experiences of vulnerable communities [15].

Vulnerability here is considered to encompass overlapping environmental, social, and economic risks, e.g., ecological and biodiversity risks arising from regional livelihoods; social vulnerabilities arising from livelihood opportunities in urban areas; and social structures in need of higher capacities for environmental ethics and values. Within these communities, the traditional livelihoods in the rural agricultural sector were increasingly being replaced and/or supplemented with livelihoods in the urban service sectors, e.g., "*biscates*", gardening, civil constructions, and housekeeping services.

Non-formal educational approaches are defined here as learning through everyday shared multidimensional community experiences [21–23]. The non-formal educational approaches that are reflected in this paper did not follow any rigid didactic plan. The conception, planning, and improvement of non-formal environmental educational activities were facilitated through diverse community-level voices. These included participative dialogue within local schools with principals, teachers, and parents. They opened up room for the exploration of educational approaches that give space to vulnerable children to reflect on local environmental challenges. Other voices included the local and state level institutions, including, for example, agricultural technicians from EMATER-Itaipava (Public Rural Extension Institute of the State of Rio de Janeiro), the Petrópolis Court of Justice, and professionals from various agencies of the city hall.

2.1. Data Collection and Analysis

Beginning in 1997 through weekly voluntary work, the lead author began to organize non-formal environmental education approaches in three elementary schools in Petrópolis, i.e., the João Pires Gonçalves, Morro dos Anjos, and Santa Isabel elementary schools. From 1998 to 2005, based on the successful experience of the first three schools, the initiatives were extended to eight other elementary schools in the region. These included the Albertos, E.M. Fazenda Jurity, E.M. Alto Independência, Celina Chechner, Darcy Correa da Veiga, Lucia de Almeida Braga, Geraldo Ventura Dias, and Águas Lindas elementary schools. From 2005 to 2016, with the support of the Petrópolis City Hall, non-formal environmental education approaches were expanded to an additional 20 local schools in the region. In addition to the elementary school level, between 2002–2007, these approaches were also practiced in Fundação *Educandário* Princesa Isabel. This institute was a special needs school for children at social risk—but it was not a juvenile prison—managed by the local judiciary and city hall.

The data collected from the above case study of 32 schools in the Petrópolis region originated from three main data sources and collection methodologies:

a. Participant observations [24], discussions, and reflections between the lead author and principals, teachers, parents, and local government officials from 1997 to 2016.
b. Examination of student outputs [24], artwork, essays, and other creative expressions such as poetry by the lead author from 1997 to 2016. A plethora of student works was accumulated and

observed during these years. However, for the purposes of this article, only two to five recent samples for each category were examined in 2015.

c. Visit to regional schools and semi-structured interviews [25] in March 2017 with principals and officials from Petrópolis City Hall's education department.

For the purposes of this article, all of the interviewees and observed participants were assured of confidentiality. Student works were anonymized before being examined.

The above collected data were analyzed through a grounded theory approach. A grounded theory approach is an inductive process focusing on the interpretation and continual application to the research [26]. Grounded theory involves the identification of categories and the development of relationships between the categories [27]. An advantage of grounded theory is the emergent qualities of its approach, which better reflect the constructed reality of the environment where the research is being conducted and of the participants in the research. Unlike a scientific theory, however, grounded theory is more context-dependent. Through the grounded theory approach, the researcher can continually compile and reflect on the data until dominant pattern categories emerge. Toward this end, the data is sorted, coded, and categorized so that they can be analyzed for prevailing categories. According to the literature, three types of coding are practiced, i.e., open coding, where first impressions and patterns emerge from the data; axial coding, where the characteristics of each pattern are defined; and selective coding, where the core patterns are established [26]. However, this process is not linear and may be circular in its progress [28]. What is important is that preliminary observed patterns are established and that additional collected data fit them and do not redefine new pattern categories, thus reaching a state of saturated maturity. As an end product of this process, grounded theory provides an explanatory understanding based on the relationships between the categories and the circumstantial social reality.

2.2. Theoretical Framework

Educational efforts can foster the ability of individuals to learn, assimilate, and deploy skills to promote the generation and diffusion of more environmentally conscious practices. By nurturing human capital, through non-formal environmental educational capacity-building approaches, the ability of these individuals to address pressing environmental challenges can be greatly enhanced.

This study applies Scott and Gough's [29] framework on rethinking the relationship between education and capacity building. The proposed framework illustrates three categories for the learning of individuals in (i) Information, (ii) Communication, and (iii) Mediation. In this framework, learning consists of two phases, i.e., Training and Education. The quality of these two phases changes in the Information, Communication, and Mediation categories, respectively. Information is described as a one-way information flow that sets agreements on facts and values. Communication is identified as a two-way flow of information that nurtures the engagement of learners with the given subjects. Mediation develops a greater degree of two-way flow of information by advancing discussions whereby facts, values, and applied assumptions are openly discussed. The emphasis in training is more present in the Information category, while the degree of emphasis on Education becomes stronger as the forms of learning lean toward the Communication and Mediation phases (Figure 1).

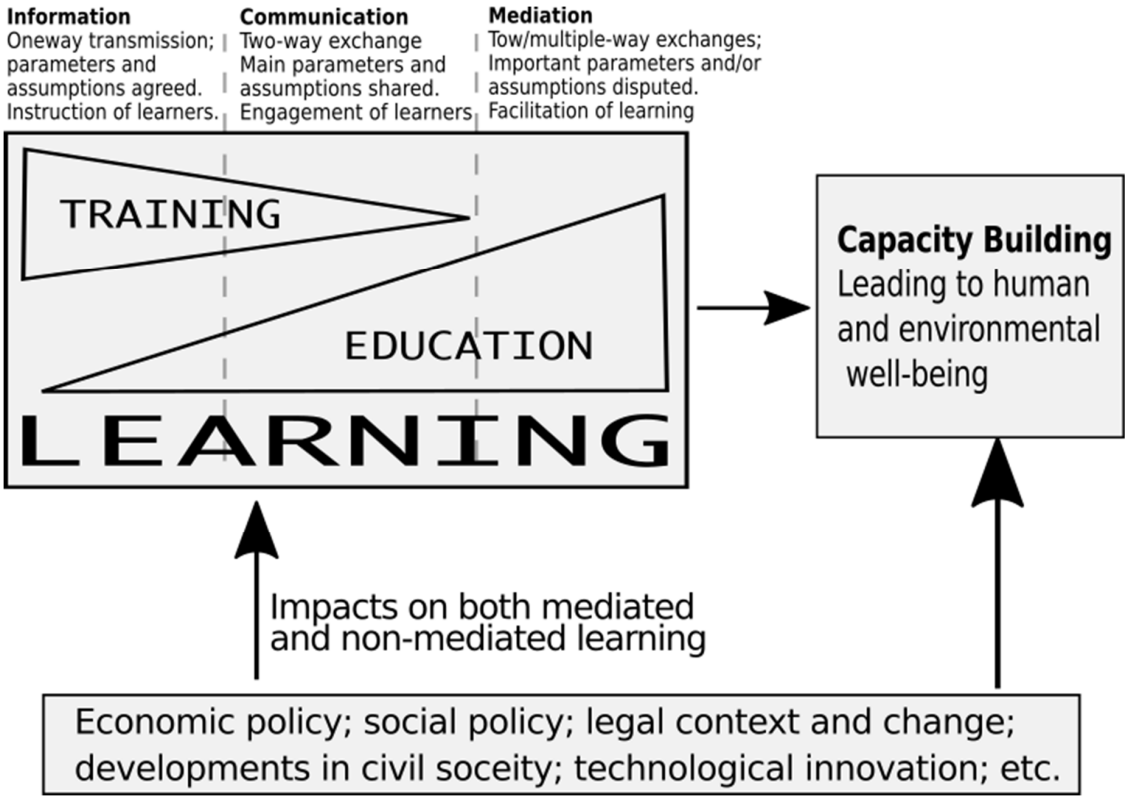

Figure 1. Information, Communication, and Mediation: Contributions to Capacity Building. Image adapted from Scott and Gough [29].

These three categories of learning can be embedded in non-formal environmental education. There are also external factors that affect the quality of learning, some which could be drivers, while some can hinder the learning processes. In this study, we apply the above framework to examine the types of learning taking place among the three categories. However, this study does not explicitly examine the specifics of the external factor. This is one limitation of the study, yet this does not imply that the authors do not acknowledge the importance of the external factors. The integrated processes of the three phases of learning are converted toward capacity building. This element of the framework is particularly relevant to the vulnerable context of the case study area of this paper. Environmental education is not just about environmental conservation and protection; it also needs to address the root causes of the environmental problems that are related to the human activities of the local region of the case study. Addressing capacity building to enable the engagement of problems and solutions to local environmental challenges is essential. Toward this end, the above framework emphasizes the relationship between environmental education and capacity building; especially in the context of the case study of this paper, this framework can highlight the effectiveness of capacity building through engagement of the youth.

The following section describes our findings from the case study in three major points. Some references were applied in the following section when presenting the results; however, this is only to present the relevance of the case study in the field of environmental education and is not intending to provide analysis. These are to report the findings that will be later analyzed based on the adopted framework on rethinking the relationship between education and capacity-building in Section 4.

3. Results

3.1. Developing Non-Formal Environmental Education

To develop non-formal environmental education in the schools, an ecological walk was initially organized by inviting a group of students. The participating students were asked to observe local environmental problems and write short essays on their reflections. From these activities, students often commonly identified three major local environmental problems, which were (i) discarded garbage, (ii) noise pollution, and (iii) unsustainable food consumption and related health issues.

The first environmental problem was regarding large amounts of garbage discarded by locals on streets, roads, and public parks. This problem was most notable when intense summer rains spread garbage into creeks and rivers. From this visual observation, children were motivated to begin discussion circles focusing on unsustainable waste management and its consequences to human health, flora and fauna, human dignity, and the negative impact of the dirty landscape on tourism. In these discussion circles, students were encouraged to approximately estimate the volume of garbage generated in the city, and also categorized the different types of garbage that had been improperly thrown away by the local population in public spaces.

The second problem was regarding noise pollution and its negative impacts on social interactions. Noise pollution, within the school environment particularly, disturbs the concentration that is necessary for students to follow the lectures, and amplifies school violence. Noise pollution was a commonly identified problem in almost all of the schools in the study area. In some schools, noise pollution is considered as the main cause of socially irresponsible behavior by the principals and teachers.

The third problem was regarding unsustainable food consumption and related health issues such as obesity. These issues reflect the complex causes arising from the vulnerable living conditions of the local communities. On these issues, students reported the different packaging wastes found during the ecological walks, e.g., bottles, tubes, cans, and plastic sacks. As a result of this reflection, discussions were extended to agriculture, industrial food, and health issues. Students were encouraged to think about the sequences of the life cycle of food, and they reflected on how food consumption was responsible for positive or negative impacts on human health. Examining food package waste explained not only environment impacts but also people's food choice and quantities. Students discussed the main influencers of people's eating habits such as parents and corporate marketing.

In order to respond to the above-mentioned unsustainable environmental and social problems of the study area, non-formal environmental education activities were developed and implemented for students in the Petrópolis region. These activities set their main foci on gardening skills, sustainable food practices, and environmental ethics. Examples of the activities and concepts used in these non-formal environmental education activities are provided in Table 1.

Table 1. Examples of the activities and concepts used in the non-formal environmental education in the case study.

Non-Formal Environmental Education	Gardening Skills	Sustainable Food Practices	Environmental Ethics
Example of activities and concepts	Teaching and practice of horticultural techniques; soil preparation; organic composting; planting schedules; crop spacing; sustainable pesticides	Discussion of the importance of nutrition, e.g., fibers, vitamins, and minerals; influence of marketing and packing of foods; organic farming and effects on soil health; the need for biodiversity	Discussion circles; aesthetic engagement through ecological walks; visual comparison of landscape before and after being cleaned; accessing the collective community memory; writing of environmental codes of conduct

3.2. Gardening Skills and Sustainable Food Practices

Using small plots of land within the schools, students were exposed to various gardening skills and sustainable food practices. These practices included basic horticultural techniques, e.g., how to structure roots for more efficient nutrient absorption, soil preparation, organic composting, planting schedules, and crop spacing (Figure 2). Students were also familiarized with environmentally conscious pesticide usage, sustainable weed and pest control techniques, and water-conserving irrigation. Through the school gardening activities, students also learned the basic challenges of small and medium-sized farms and the particular nuances of the systematic cultivation of different plants. These activities provided students with a basic understanding of the common environmental challenges in agricultural production by experimenting through a small-scale production of vegetables using scarce resources. To match school schedules and receive quick results, students mainly planted cultivars that could be harvested after 45/60 days. These included for example, lettuce, carrots, broccoli, kale, rocket, spinach, and beetroot. After harvesting, the produce was freshly consumed by the students, used in the school's cafeteria, or given to students to take home and share their experience with their families.

Figure 2. Atila Calvente (right) and local school children engaging in a crop-spacing exercise.

Researchers from various disciplines have consistently found that school gardens contribute to the balanced diet of children and young adults [30–33]. In our case study, students were encouraged to reflect on what is being planted and discuss the importance of fibers, vitamins, and minerals that are needed for human nutrition. This enabled students to better grasp the fundamentals of healthy diets and the importance of food diversity. Specifically, students were asked to research the nutritional contents and vitamins of each vegetable. For example, students learned that carrots are rich in vitamin A, which is good for skin health, while kale is rich in vitamin B, which is good for the human nervous system. Direct contact with soil and nutritious plants have been found to be instrumental in tackling and raising awareness on the challenges of food security, nutritional deficiencies, and obesity among children and young adults [34–36]. Furthermore, this may allow children to become less influenced

by the marketing and packing of food, focus more on nutritional values and, hence, increase their knowledge capacity of healthy diets.

The literature on environmental education emphasizes interdisciplinary and field-based learning approaches for instilling concepts of organic farming among students [37]. In our case studies, students were introduced to organic farming principles by understanding the importance of maintaining soil and the health of the millions of soil microfauna that are essential for plant growth. In this avenue, students were taught the dangerous effects of overusing popular glysophate weed killers [38]. In Brazil, the large-scale use of chemical fertilizers, herbicides, pesticides, and soil mechanization has promoted the growth of large amounts of cereals, meat, and vegetables since the green revolution of the 1950s [39]. However, this exponential growth has also negatively impacted the environmental health of the agricultural lands in Brazil. Tying in with the precautionary principle, students were encouraged to reflect on the trade-offs between short-term high yields against long-term soil health. From these discussions, students became more aware of the philosophy behind organic farming and were introduced to basic organic farming approaches, e.g., composting, organic fertilizers, and natural pest control.

The topic of biodiversity was also encouraged among students through the planting of native trees. These trees included the jacarandá, ipê, pau mulato, araçá, guanandi, aroeira, and other species of the original Mata Atlântica Forest, which is under the threat of extinction. The local community and farmers usually donated these trees, and were enthusiastic in helping toward such activities. Students were taught how to dig the earth with a sufficient depth for the roots to take hold, and were also instructed to maximize the limited amount of land by planting each tree every 3.5 m, while planting a bean plant in between every tree. Students and the local community exhibited great enthusiasm for such actions toward recovering environmentally degraded areas.

3.3. Environmental Ethics and Values

School garden activities provided non-formal educational lessons on environmental ethics and values to vulnerable students of the Petrópolis region. These approaches aimed at strengthening the moral sensibility of students toward environmental problems and encouraging them to understand the multidimensional aspects of environmental problems. The ability to engage in play and participatory activities is emphasized by researchers toward successful environmental education [40]. Too often, in formal classroom settings, students are required to only listen to teachers, follow a rigid traditional curriculum, and rely on memorization rather than interactive education. By placing the non-formal environmental education in outdoor settings, students were provided with a setting in which they could be more engaged and create discussion circles with their peers while practicing gardening.

Whilst gardening, students were encouraged to discuss the ethical responsibilities of humans toward nature. These *discussion circles* provided opportunities for students to learn the basic principles of environmental concepts such as sustainable ecosystem services, the precautionary principle [41], biodiversity degradation, water conservation, and intergenerational ethical conflicts [42]. In these discussion circles, the environmental concepts were made palpable by bringing to attention local environmental problems. For example, students were asked to estimate through simple mathematics the volume of garbage discarded on the streets and rivers, their effects on human health and local landscapes, and the long time that is required for their degradation and composting in nature.

The ecological walks encouraged students to better develop an aesthetic engagement [43,44] between the many interdependent dimensions of local environmental problems. In these walks, students were exposed to natural landscapes, and learned how human communities and urban development affected these landscapes. Specifically, students collected, photographed, and learned to categorize various waste (e.g., plastic bags, medicine containers, needles, paper, cardboard, pieces of furniture, and vehicle tires). Upon seeing and collecting these items, students often quipped, "These don't belong here!" These activities led students to discuss the negative effects of each waste type on the environment, and how to dispose them. Lessons from ecological walks were especially

effective when students were retaken to areas that previously had large amounts of waste, e.g., household waste in urban areas and agrochemical container waste in agricultural fields, but were significantly cleaned. In these areas, students were encouraged to compare their current visual perceptions to how the landscape looked before being cleaned.

Sustainable and ethical water usage was another key learning theme within the non-formal environmental educational approaches. Especially after the 2014 Caxambu Water Crisis, where the Federal Military Police at one point attempted to stop all of the agricultural water consumption to meet the water demand of the city of Petropolis, the significance of water was palpable among students. In classroom discussions, students were taught about the importance of water management and criticality of water conflicts. Interestingly, a common eye-opener for students was realizing that there are limited amounts of fresh water available to humankind, and that 97% of global water is salinized. During the ecological walks, students observed creeks and rivers near the local community of the schools. Here, students were introduced to the concept of ecosystem services for agricultural needs and how human actions, e.g., dumping garbage in the waterways, cutting trees, and irrational water demand, are damaging sustainable water resource management. Students were encouraged to ask their grandparents and older community members about past changes to the landscapes and waterways due to the cutting of trees and the subsequent negative effects on water flux in their communities. By accessing the collective community memory, students were able to better understand the socio-environmental conflicts arising from water resource management, especially in the dry season in Brazil, i.e., from June to September, and also envision future hardships due to climate change.

In line with the aim of integrating concepts and the practice of environmental ethics, students were encouraged to write simple "environmental codes of conduct". These codes of conduct were conceived by the children to better motivate and guide the local communities and schools toward better environmental preservation, protection, and more broadly toward strengthening behaviors for sustainable transformations. The environmental code was in essence a democratic exercise where students as young as the ages of 10 and 12 reflected on local environmental issues, and pointed to some norms and directions of conduct to be cultivated and disseminated in their communities. Furthermore, the process of developing the environmental codes of conduct contributed to nurturing a higher level of environmental ethics and values. The developed environmental codes include the following articles:

- Article 1: Do not throw rubbish, plastics, tires, furniture, oil, pesticides, and other materials on the streets, public places, and rivers of your neighborhoods and places of work in the field.
- Article 2: Take care of all flows of water to guarantee water to future generations.
- Article 3: Do all you can to spread the idea of clean and pure water in the future.
- Article 4: Motivate people to plant native and fruit trees in all types of landscapes. Motivate farmers to avoid the use of slash-and-burn techniques for cleaning planted areas. Plant trees along water sources, rivers, and streams.
- Article 5: Arrange events to commemorate the freedom of birds, and on that day, free caged birds and identify places where birds are in cages.
- Article 6: Motivate other children, their parents, and friends to eat more organic vegetables and healthier foods to avoid and reduce obesity.
- Article 7: Help organize environmental education practices through school and home gardens, and make herbs and flowers that increase the quality of life available.

While practicing their gardening skills, students were asked to compare root structure and plant development to an environment that is beneficial for human development. This comparison strengthened the belief that similar to how plants needed to focus their roots toward the goal of absorbing soil nutrients and growth, children also needed silence and the ability to concentrate in the classroom for advancing their personal and educational goals. Toward this end, students were asked to reflect on their personal and educational goals, independent of formal classroom top–down rules or penalties, and develop an "environmental values wheel" conducive to these goals. This values wheel

allowed children to relate in their own thoughts their attitudes toward excessive sound pollution and school violence, and encourage a better environment for personal development and sustainable social interaction.

Finally, students were also encouraged to reflect on environmental challenges through the use of creative arts and literature. These included short reflective essays on environmental aesthetic issues, short student plays, paintings, and poetry. Through these activities, children were encouraged to creatively interpret a multiplicity of environmental problems, e.g., paintings on unsustainable waste disposal, poems and songs encouraging sustainable human nutrition, and the organization of plays to discuss biodiversity and the protection of water resources.

4. Discussion and Conclusions

This paper presents a descriptive summary of the non-formal environmental education experiences in more than 20 schools in vulnerable communities of the Petrópolis region in Brazil. The educational development of children can succeed through real-life and practical experiences, where students can strengthen their ability for reflective thinking and manage meta-cognitive knowledge processes [45]. The non-formal environmental educational approaches that have been described in this paper were aimed at providing students with the space to reflect and respond to the commonly identified unsustainable social-environmental challenges of the Petrópolis region. Toward this end, non-formal environmental education activities were developed with a focus on gardening skills, sustainable food practices, and environmental ethics.

The progress of non-formal environmental education during the years was gradual, and its success was critically dependent on the involvement of school management, parents, and the local community. At the beginning of the first phase in 1997, the lead author had to prove the potential value of these educational approaches by convincing the local principals, using his own limited financial resources and volunteering his time. In practice, this meant that these approaches were limited to activities within the school premises and focused on conveying gardening skills to the students. In the second (1998 to 2005) and third phases (2005 to 2016), the non-formal environmental education approaches received more attention and support from the teachers and the principals, and gradually garnered the support of the local city hall administration. As one city hall official said: "Looking back, it took us some time to be convinced of the deep impact [that] these activities could have on the youth, their families, their communities, and their environment." This institutional support resulted in more activities taking place in the surrounding areas of the local schools, for example, ecological walks, and the discussion of environmentally-conscious lifestyle choices with the students, for example regarding sustainable food practices. However, the most critical support came from the involvement of the local community. This was evident, for example, in the planting of native trees by children, with the support of the bus companies and the local public institutions to transport people to plant the trees. However, the non-formal environmental educational approaches did not follow a rigid structure and design, and in this paper, we have highlighted what have been the most successful observations. Nevertheless, these approaches may inspire future educational approaches and environmental social movements that focus on the youth and their vulnerable communities.

Environmental education may be more effective when children observe local environmental problems first-hand. Through these observations, students are able to think, reflect, conceive, plan, and implement basic collective sustainable transformations. Similarly, searching for the meaning of environmental ethics reflecting local environmental problems leads to a better comprehension of the multidimensional economic, social, and cultural challenges facing the generation of the students for year to come. At the very minimum, children should have the opportunity to better understand how current and previous generations continue to impact the environment. Non-formal environmental education approaches may provide such a platform and empower the next generation to evaluate their positive or negative impacts to the environment and construct sustainable future societies.

The framework on the relationship between education and capacity-building [29] outlines three categories (Information, Communication, Mediation) within training and education to be provided to the participants. The success of the non-formal environmental approaches in the case study of this paper can be partially explained by responding to each of these categories. In particular, Information was achieved through a one-way transfer and instruction of gardening skills, including, for example, horticultural techniques, soil preparation, organic composting, and planting schedules. Communication was achieved through activities such as the ecological walks, discussion circles, and aesthetic engagements whereby the understanding of students on the subjects were nurtured in a two-way flow of information. Mediation was achieved for example through the development of the environmental codes of conduct whereby the learning of students was facilitated and values were openly discussed. We identified the interlinkages of these three categories as important to help the participants experience a gradual shift from receiving the training phase to obtaining the education phase. Different forms of learning took place in the three categories, yet the planned activities were not necessarily designed based on applying an integrated framework. Therefore, a more efficient learning design will enable non-formal environmental education to achieve more impactful capacity-building among the youth.

Local governments and educational institutions should dedicate more attention to action research approaches to advance new possibilities of social cohesion toward sustainable transformations in Brazil and elsewhere throughout the world. In this avenue, this paper intends to open a broader discussion on ways to manage local environmental challenges through non-formal environmental education approaches. It is hoped that this paper motivates future studies toward integrating more non-formal environmental education case studies with post-constructivist action research approaches. This includes more research toward expanding non-formal environmental education approaches to rural schools and linking local social, environmental, and economic challenges to new pedagogical objectives.

The non-formal environmental education approaches may help promote popular mobilization, deep critical reflection, and the development of sustainable practices that are in tune with local realities. In addition to environmental education in schools, it is necessary to increase the capacity of the families of the students to engage in critical reflections of their environment and diffuse sustainable ideas and practices amongst their communities. In this avenue, university–community engagements and the ability to increase the capacity of local agents to engage in transformations toward sustainability is essential.

In Brazil, researchers have emphasized the necessity of environmental education and the need for developing collective interpretations and actions toward tackling the unequal and degraded socio-environmental realities [46–48]. Through interdisciplinary reflective interpretations, educators can motivate students to search and discuss local environmental problems. In this avenue, school gardens can be instrumental for students in reflecting upon the ethical relationship between humans and nature and learning gardening skills and sustainable practices. In addition, as a non-formal environmental education approach, school gardens relay a sense of autonomy, empowerment, self-awareness, and provide a space for students to define meaning in their lives in the context of the environment in which they live.

In our observations, school gardens provided students with more than environmental education; it also increased their ability to tackle social challenges. Many of the vulnerable children lack family structure, wander the streets, disregard their studies, and lose the opportunity for mental development at an early age. The worst happens when students seek the path of drugs and social marginalization. Such social ills have been traditionally treated in Brazil, both by the political and academic classes with a strong emotional context and generic top–down political–pedagogical projects without any sense of pragmatism. In this context, pedagogical practices outside the classroom are better poised for approaching social ills. Non-formal environmental education can be better suited to the reality of the local communities and allow children to plan and guide their own educational learning, and thus develop within them a deep sense of competency and courage.

Author Contributions: A.C. engaged in non-formal environmental education and was the main author and lead investigator. A.K. interviewed, collected data, designed the research, and was also the main author. S.K. developed the framework, contributed to the research design, and contributed to the writing of the paper. P.S. contributed to the writing of the paper and provided editorial inputs.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflicts of interest.

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